Inferences About Contributions to λ

Population Modeling
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Reverse-time Modeling

- Reverse-time modeling can be viewed as CJS modeling with a time-reversed data set
- It differs from temporal symmetry models in not requiring any survival parameters
- Instead we simply condition on the final capture and model the previous capture history data

Reverse-time Modeling: Parameters

γ_i= seniority parameter; probability that an animal in the sampled population at period *i* was also in the sampled population at *i*-1

p_i= capture probability at period *i*

Notation of Pradel (1996)

Reverse-time Modeling

$$P(0101 | \text{Last caught at 4}) = \gamma_4(1-p_3)\gamma_3 p_2(1-\gamma_2 p_1)$$

γ_i = probability that an animal in population at *i* is a survivor from the previous period

1- γ_i = probability that an animal in population at *i* is a new recruit

Reverse-time Modeling: Potential Uses

- Estimation of the proportional contribution of different demographic components to population growth, e.g.,
  - surviving adults vs. new recruits
  - recruits from *in situ* reproduction vs. immigration
  - same-location vs. different-location survivors

Seniority and Contributions to λ: 1-Age Class Model

$$E(\lambda_i) \approx \frac{E(N_{i+1})}{E(N_i)}$$

$$\approx \frac{\gamma_{i+1}N_{i+1} + (1-\gamma_{i+1})N_{i+1}}{E(N_i)}$$

The seniority parameter, γ_{i+1}, decomposes N_{i+1} into 2 components, survivors and new recruits

Seniority and Contributions to λ: How Does This Work?

- Address questions such as "If survival had been reduced by proportion α (i.e., multiplied by 1- α), what would λ_i have been?"
- $\lambda_i(1-\alpha\gamma_{i+1})$

Seniority and Contributions to λ: 2-Age Class Model

- Basic idea: partition adult population growth rate into 3 components:
  - Surviving adults from the previous period
  - Surviving young from the previous period (under some assumptions this is reproductive recruitment)
  - New immigrant recruits from outside the sampled population

Seniority and Contributions to λ: 2-Age Class Model

- 2-Age models for forward time
  - Transitions from ages 1 to 2 are deterministic
- 2-Age models for reverse time
  - Transitions from age 2 to 1 are stochastic
  - Thus require general multistate models

Seniority and Contributions to λ: 2-Age Class Model Notation

- γ_i^{22} = Pr(adult [2] in pop at time i-1 | adult in pop at time i)
- γ_i^{21} = Pr(young [1] in pop at time i-1 | adult in pop at time i)
- 1- γ_i^{22} -γ_i^{21} = Pr(outside study pop at time i-1 | adult in pop at time i)

Seniority and Contributions to λ: 2-Age Class Model

$$E(\lambda_i^2) \approx \frac{E(N_{i+1}^2)}{E(N_i^2)}$$

$$\approx \frac{\gamma_{i+1}^{22}N_{i+1}^2 + \gamma_{i+1}^{21}N_{i+1}^2 + (1-\gamma_{i+1}^{22}-\gamma_{i+1}^{21})N_{i+1}^2}{E(N_i^2)}$$

The seniority parameters, γ^{2r}_{i+1}, decompose N_{i+1} into 3 components, surviving adults, surviving young and new immigrant recruits

Seniority and Contributions to λ: 2-Age Class Model

- Yields estimated contributions of:
  - Same-location adults from last period
  - Same-location young from last period
  - Immigrants (not same location last period)
- Some view last 2 contributions as relevant to source-sink arguments

Seniority and Contributions to λ: Multiple Locations

- Multistate reverse-time analyses can be used to estimate contributions of different locations to each other and entire metapopulation system
- Uses same kinds of thinking as this lecture

Seniority and Contributions to λ: Summary

- The seniority parameters of reverse-time modeling can provide inferences about contributions of different demographic components of a population to λ
- No claim that these inferences can not be obtained in other ways
- Instead, reverse-time modeling provides a natural and convenient approach